INDOOR AIR QUALITY ASSESSMENT

Malden High School
B-Building
77 Salem Street
Malden, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of building occupants, the Massachusetts Department of Public Health (MDPH) Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality concerns at Malden High School (MHS), 77 Salem Street, Malden, Massachusetts. Occupant concerns (e.g., exacerbation of allergies related to potential mold growth) in the B-building, primarily the guidance suite, prompted the request. On June 9, 2006, Cory Holmes, an Environmental Analyst for CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program, conducted an IAQ assessment at the B-Building of MHS. Mr. Holmes was accompanied for portions of the assessment by Chris Webb, Director of the Malden Health Department and Ron Lessard, HVAC technician for the City of Malden.

MHS was originally built in the early part of the 20th century (1920s); additions were constructed in the early 1970s. The building is currently between its second and third phases of major renovations.

Methods

Air tests for carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-TRAK™ IAQ Monitor, Model 8551. CEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The B-building at MHS houses approximately 405 high school students in grades 9-12 with a staff of approximately 200. Tests were taken during normal operations at the school and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were below 800 parts per million (ppm) in all areas surveyed, indicating adequate ventilation in areas surveyed during the assessment. However several areas were empty or sparsely populated and/or had open windows. Low occupancy and/or open windows can greatly reduce carbon dioxide levels.

Mechanical ventilation is provided by three-large rooftop air-handling units (AHUs) equipped with high efficiency pleated air filters (Pictures 1 and 2). Fresh air is continuously distributed via ceiling-mounted air diffusers and ducted back to AHUs via ceiling-mounted return vents (Pictures 3 and 4). These systems were operating during the assessment. Mr. Lessard reported that fresh air intake was set at 100 percent at the time of the assessment (Picture 2).

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing was not available at the time of the assessment, however all HVAC systems will be replaced over the next year during the third phase of renovations.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult Appendix A.

Temperature measurements ranged from 70^o F to 73^o F, which were within the MDPH recommended comfort range. The MDPH recommends that indoor air temperatures be maintained in a range of 70^o F to 78^o F in order to provide for the comfort of building occupants. Although temperatures were within the recommended comfort range, temperature control complaints from occupants were expressed to MDPH staff during the assessment. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 63 to 70 percent, which was above the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Outside humidity was 85 percent at the time of the assessment; therefore with the AHUs drawing 100 percent fresh air, these higher relative humidity levels would be expected. While temperature is mainly a comfort issue, relative humidity in excess of 70 percent for extended periods of time can provide an environment for mold and fungal growth (ASHRAE, 1989). During periods of high relative humidity (late spring/summer months), windows and exterior doors should be closed to keep moisture out when the HVAC system is air conditioning mode. During the heating season, relative humidity levels would be expected to drop below the recommended comfort range. The sensation of dryness and irritation is common in a low relative humidity environment. For buildings in New England, periods of low relative humidity during the winter are often unavoidable.

Microbial/Moisture Concerns

As previously mentioned, due to exacerbation of allergies and mold concerns, CEH staff conducted a through visual examination of the guidance suite. No water damage, visible mold growth and/or associated odors were observed in this area. However, what appeared to be plant debris and pooling water was observed on the roof directly outside the guidance suite (room B-207), (Picture 5) at the time of the assessment. Pooling water and saturated plant debris can provide a potential medium for mold growth and associated odors. Given that it was outside the window and not near any fresh air intakes for the mechanical ventilation system, direct exposure is not a concern. However it is recommended that the area be cleaned and disinfected.

Active roof leaks in other areas of B-building were observed, specifically classroom 420 (Picture 6) and in the 4th floor hallway outside of B-418, where water was dripping and pooling on floor tiles (Picture 7). Water-damaged ceiling tiles can provide a source of mold and should be replaced after a water leak is discovered and repaired. A historic plumbing leak was reported in classroom B-424. CEH staff removed ceiling tiles (Picture 8) to inspect the ceiling plenum. No current water damage, visible mold or associated odors were detected, however, the plumbing fixture which appeared to be the past source of water damage was severely corroded (Picture 8).

The US Environmental Protection Agency and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur.

Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Other IAQ Evaluations

School officials reported that a hazardous waste disposal company was summoned to go through the chemicals present in the laboratories and remove unwanted or unused materials prior to the 2005-2006 school year. CEH staff examined conditions in the B-420 prep room. An irritating chemical odor was detected (Picture 10) upon opening a tall wooden chemical storage cabinet. Several damaged containers were observed (Picture 11) as well as bottles which had crystallized materials on the outside of the containers indicating leakage (Picture 12). The top of the cabinet had a hole (Picture 13), presumably an exhaust vent to remove odors to the outside of the building. However, during the assessment the vent was actually backdrafting *into* the cabinet, which can force off-gassing chemicals/odors into the prep room and adjacent areas. The National Fire Protection Agency (NFPA) does not require venting in flammable storage cabinets. However, it is recommended that if a flammables storage cabinet is connected to a vent system, the vent system should not be constructed in a manner to provide an oxygen source to the interior of the cabinet and it must be vented directly outdoors and not in a manner which might compromise the specific performance of the cabinet (NFPA, 1996). There did not appear to be a mechanical exhaust fan in the ductwork nor a damper of any sort to prevent backdrafting into the cabinet. This was evidenced by the presence of corrosion on the metal louvers of the ceiling-mounted air diffuser directly outside the cabinet (Picture 14).

Other potential chemical storage issues were identified including:

- Materials were labeled with chemical formula instead of chemical name (Picture 15);
- Flasks sealed with rubber stoppers (Picture 15);
- No lip on the edges of storage shelves (Picture 15);
- Acids stored beneath the sink instead of an acid storage cabinet (Picture 16).

Several other conditions that can also affect indoor air quality were noted during the assessment. In guidance office B-207 as well as other office areas and classrooms, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up (Picture 17). Dust can be irritating to eyes, nose and respiratory tract.

Portable fans, supply and return vents were observed with accumulated dust (Pictures 18 through 20). If return vents are not operating, backdrafting may occur, resulting in re-aerosolization of accumulated dust particles; supply vents and portable fans can also aerosolize dust particles when activated.

Accumulated chalk dust was also noted in classroom B-424. Chalk dust is a fine particulate, which can be easily aerosolized and is an eye and respiratory irritant. Several areas contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Clean accumulated debris periodically from around roof drain outside of guidance room B-207 to remove/prevent mold growth and associated odors.
2. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
3. Ensure roof/plumbing leaks are repaired and replace water damaged ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
4. Consider restoring local exhaust ventilation for chemical storage cabinet. If not feasible consider removing ductwork from flammable cabinet and sealing hole to render cabinet airtight.
5. Continue to do a chemical inventory in the school. Properly store flammable materials in a manner consistent with the local fire code. Discard old hazardous

materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations.

6. Label chemical containers with the chemical name of its contents.
7. Remove acids from below sink. Obtain and store in an acid storage cabinet.
8. Relocate or consider reducing the amount of materials stored in offices and classrooms to allow for more thorough cleaning.
9. Clean portable fans, supply and return vents regularly to prevent excessive dust build-up.
10. Replace missing ceiling tiles, to prevent the egress of dirt, dust and particulate matter into classrooms.
11. Clean chalkboards and trays regularly to avoid the build-up of excessive chalk dust.
12. Consider adopting the US EPA (2000b) document, "Tools for Schools", as an instrument for maintaining a good indoor air quality environment in the building. This document is available at: http://www.epa.gov/iaq/schools/index.html.
13. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at: http://www.state.ma.us/dph/MDPH/iaq/iaqhome.htm.

References

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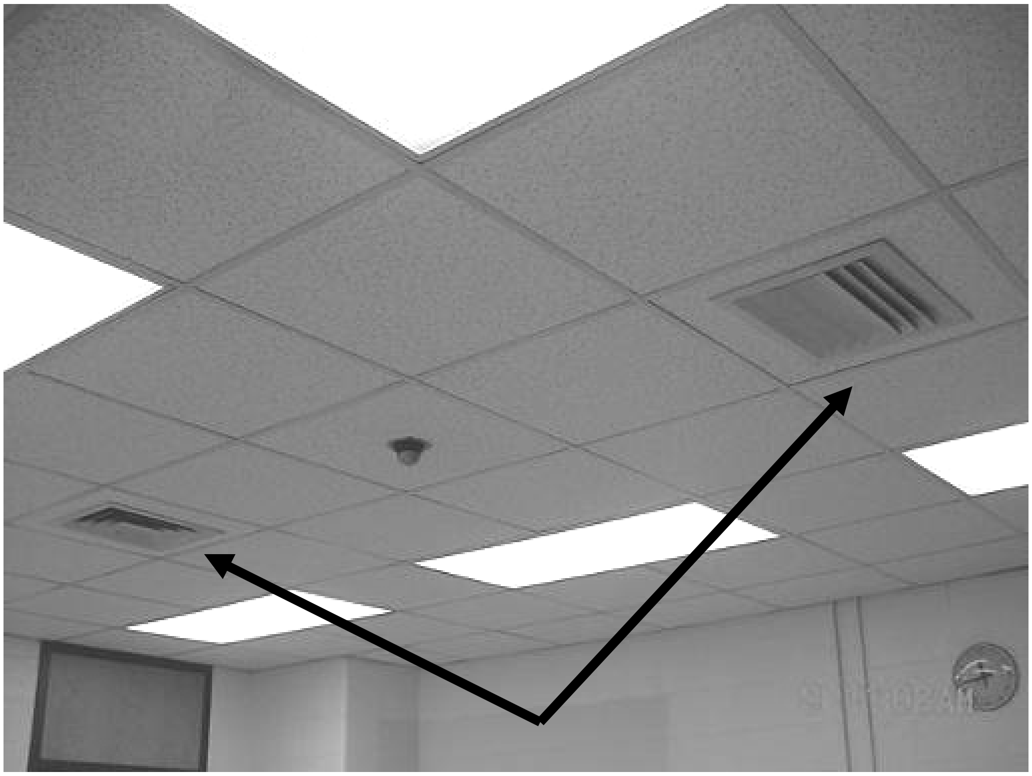
Picture 1

One of Three Rooftop AHUs for B-Building

Picture 2

Fresh Air Intake Louvers Fully Opened (100%) and Pleated Air Filters

Picture 3

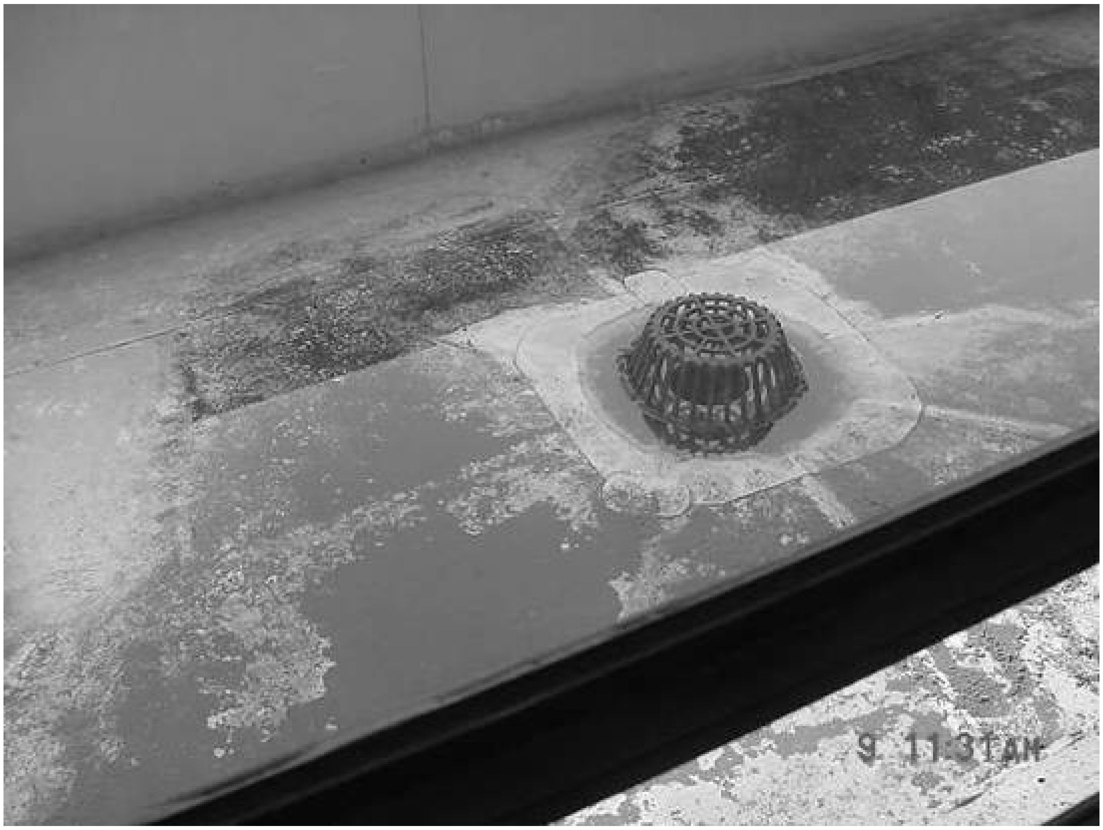


Ceiling-Mounted Supply and Return Vents

Picture 4

Slotted Air Diffuser along Perimeter

Picture 5



Black, Mold-Like Debris Accumulated around Roof Drain outside Guidance Office B-207

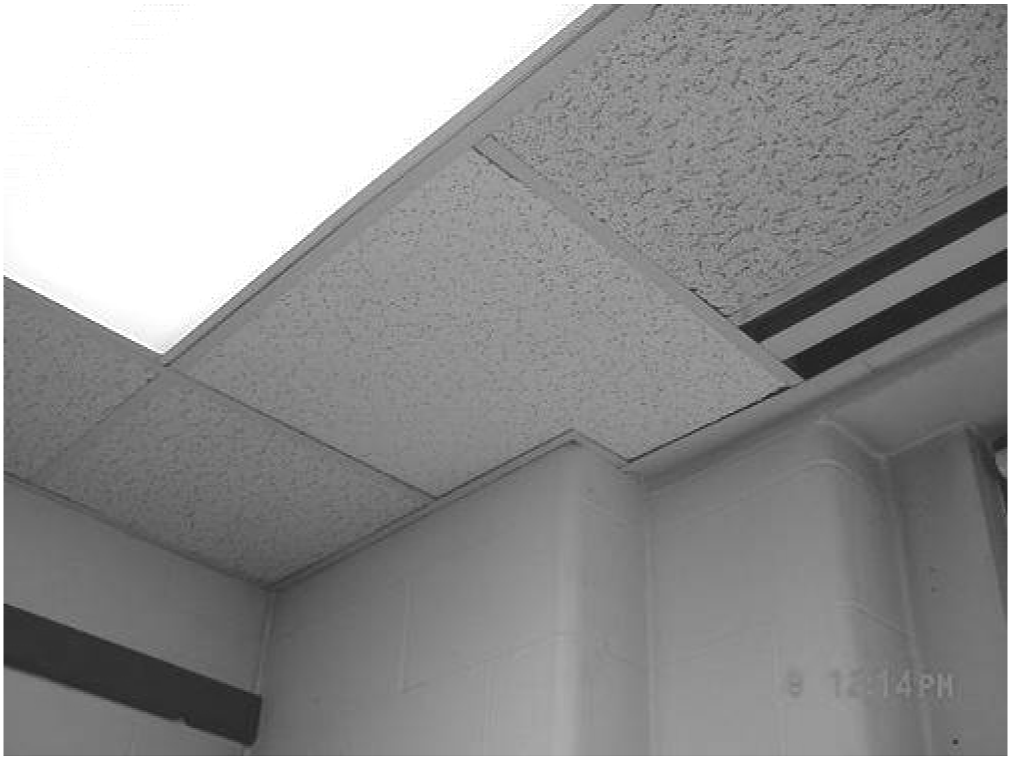
Picture 6

Water Damaged Ceiling Tile in Classroom B-420, Indicating Current Leak

Picture 7

Water Damaged Ceiling Tile in 4th Floor Hallway outside Classroom B-418, Indicating Current Leak

Picture 8



Area of Historic Water Damage in Classroom B-424, Note New(er) Ceiling Tile

Picture 9

Severely Corroded Pipe above Ceiling Tiles in Preceding Picture Classroom B-424

Picture 10

Wooden Chemical Storage Cabinet in Prep-Room B-420

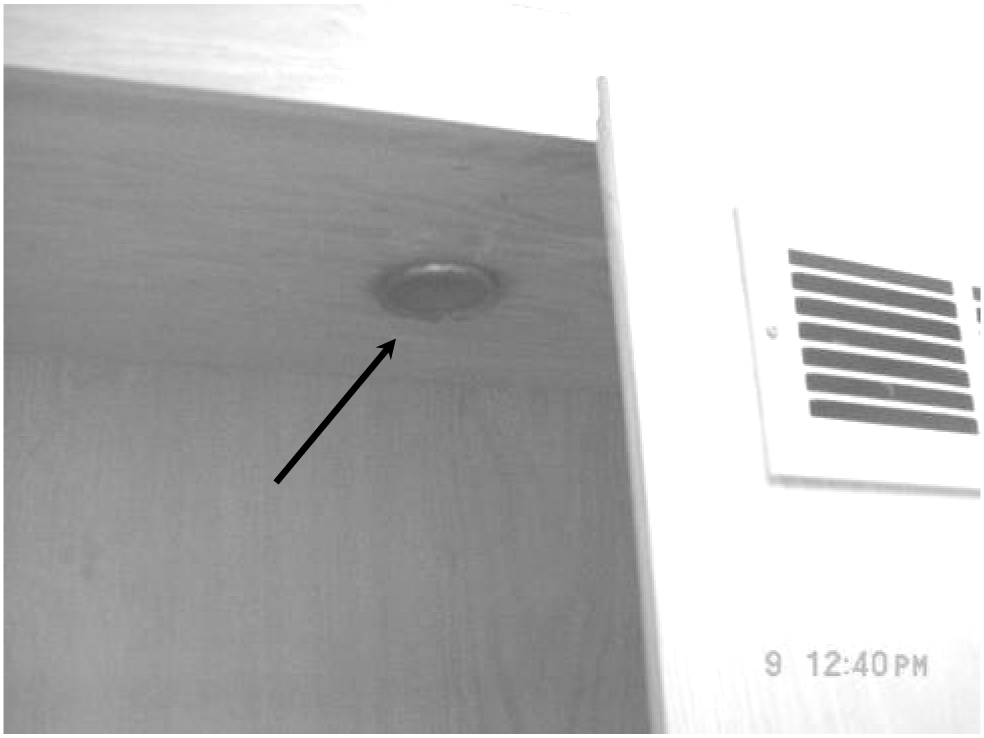
Picture 11

Damaged/Stained Containers at Bottom of Wooden Chemical Storage Cabinet in Prep Room B-420

Picture 12

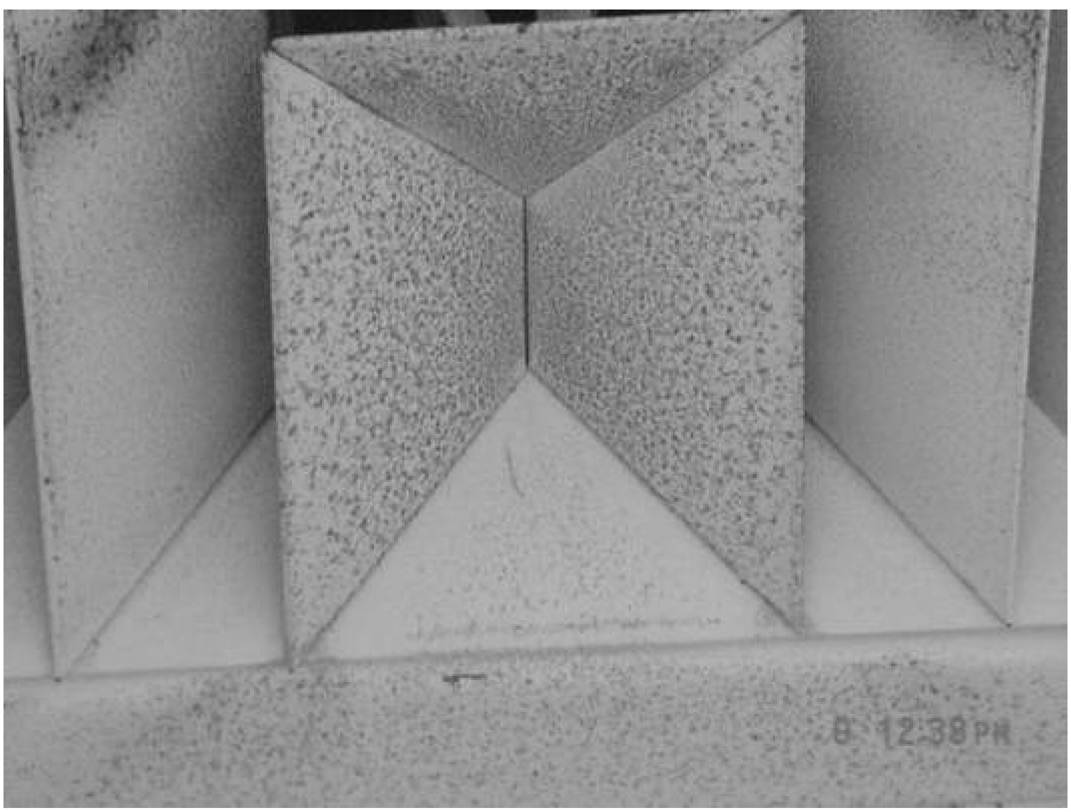
Crystallized Material on Container in Wooden Chemical Storage Cabinet in Prep Room B-420

Picture 13



Opening to Ductwork in Top of Chemical Storage Cabinet, Prep Room B-420

Picture 14



Corrosion on Surface of Metal Air Diffuser outside of Chemical Storage Cabinet, Prep Room B-420

Picture 15

Flask with Rubber Stopper Labeled with Chemical Formula

Picture 16

Acids Stored Under Sink in Prep Room B-420

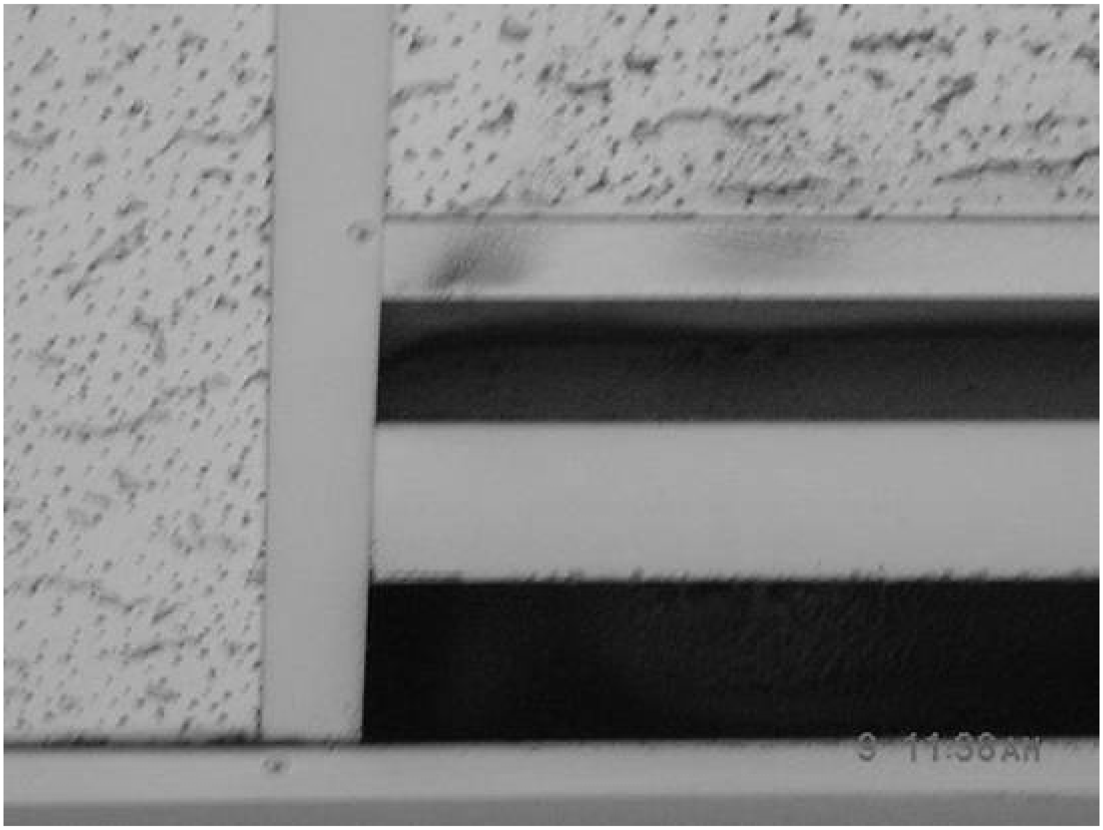
Picture 17

Accumulated Dust on Flat Surfaces in Guidance Office B-207

Picture 18

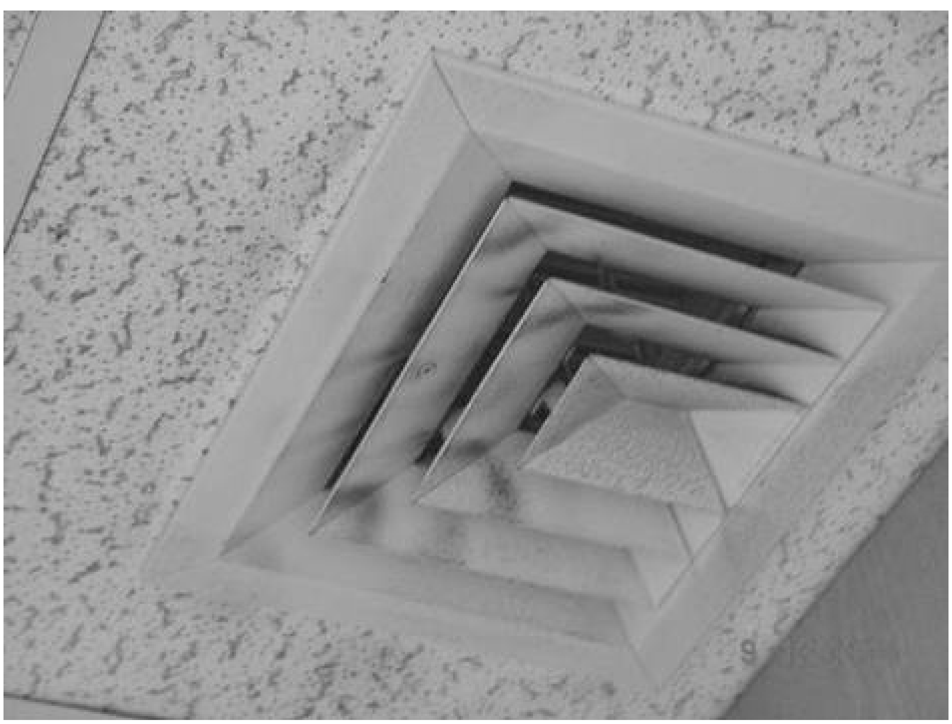
Dust Accumulation on the Blades of Portable Fan

Picture 19



Dust/Debris Accumulation on Slotted Air Diffuser

Picture 20



Dust/Debris Accumulation on Louvered Air Diffuser

TABLE 1

Indoor Air Test Results – Malden High School, B-Building, Malden, MA – June 9 2006

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background	358	60	85					Heavy clouds, rain pending
Principal's Office	618	71	70	0	Y	Y	Y	
Main Office	690	72	69	6	Y	Y	Y	Window open, plants
B-424	694	73	66	2	Y	Y	Y	20 occupants gone 2 minutes, chalk dust, DO
B-207	478	70	67	0	Y	Y	Y	Accumulated items, dust accumulation on flat surfaces, fan blades, black, mold-like debris outside office on roof near drain, DEB
B-206	502	71	66	0	Y	Y	Y	Dusty vents/CTs
B-420	614	72	65	16	Y	Y	Y	WD CT-wet (left corner) active leak
B-420 prep room	644	72	65	0	N	Y	Y	Vent for acid cabinet-backdrafting, damaged materials, odors in locker, acids under cabinet, no lips on storage shelves, MTs

*** ppm = parts per million parts of air, CT = water damaged ceiling tile**
PF = personal fan, DO = door open, DEM = dry erase materials
MT = missing tile

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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Indoor Air Test Results – Malden High School, B-Building, Malden, MA – June 9 2006

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
B-421	584	72	63	1	Y	Y	Y	24 occupants gone 2 minutes
4th Floor Hallway								Active leak outside of B-418

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